

Since Professors Fitzgerald & Kingsley first published the first edition in 1952, a consistent theme of **ELECTRIC MACHINERY** has been an emphasis on the development of both physical insight into the characteristics of electric machinery as well as facility with the analytical techniques used to describe their performance. Much has changed since the publication of the first edition; the development of lower-loss electrical steels, rare-earth permanent-magnet materials, improvements in manufacturing techniques, and the advent of power-electronic control and drive systems. The net result is that modern electric machines achieve higher efficiency and are found in an ever-increasing number of applications.

However, the basic principles which govern the performance of electric machinery remain unchanged. The long-standing reputation of **ELECTRIC MACHINERY** stems in great part from the emphasis on these fundamental principles. The challenge in producing each new edition is to appropriately “modernize” the treatment while retaining this basic focus. Modernization in previous editions has included an introduction of rare-earth permanent-magnet materials, the inclusion of permanent-magnet ac machines, variable-reluctance machines, and stepping motors as well as a discussion of field-oriented control algorithms.

A significant addition to the sixth edition was the introduction of MATLAB[®] for use in examples and practice problems as well as in end-of-chapter problems. MATLAB¹ is widely used in many universities and is available in a student version². Although very little in the way of sophisticated mathematics is required of the reader of **ELECTRIC MACHINERY**, the mathematics can get somewhat messy and tedious. This is especially true in the analysis of ac machines in which there is a significant amount of algebra involving complex numbers. Analytic tools such as MATLAB can relieve the student of having to perform lengthy calculations which in themselves do little to enhance understanding.

Consider: At the time of the publication of the first edition, the chief computational tool available to students was the slide rule. Using only a slide rule, calculating the performance of an induction motor at a single load point, which involves solving equations with complex arguments, is a significant task which can be quite time consuming and which leaves many opportunities for calculation error.

Fast forward to 2013. A MATLAB script to solve the same problem can be easily written and debugged in a matter of minutes, with the solution then obtained essentially instantaneously. With only a slight modification, the same script can be

¹ MATLAB and Simulink are registered trademarks of The MathWorks, Inc., 3 Apple Hill Drive, Natick, MA 01760 (<http://www.mathworks.com>).

² The MATLAB Student Version is published and distributed by The MathWorks, Inc. (<http://www.mathworks.com>).

used to calculate, plot and investigate the performance of the motor over its complete operating range as well as to study the effects of parameter changes, etc.; a task which, if performed with a slide rule (or even a calculator), would require the repeated calculation of many operating points, with each calculation as time consuming as the first.

It should be emphasized that although MATLAB has been chosen for ELECTRIC MACHINERY, equivalent alternative numerical-analysis programs, of which there are many, can be used with equal effectiveness. The key point is that the use of such programs immensely reduces the computational burden on the student and thus significantly increases his/her ability to focus on the principles under consideration.

Note that, even in cases where it is not specifically suggested, most of the end-of-chapter problems in the book can be worked using MATLAB or an equivalent program. Thus, students who are comfortable using such tools should be encouraged to do so to save themselves the need to grind through messy calculations by hand. When solving homework problems, students should still of course be required to show on paper how they formulated their solution, since it is the formulation of the solution that is key to understanding the material. However, once a problem is properly formulated, there is typically little additional to be learned from the number crunching itself. The value of working examples and end-of-chapter problems is derived primarily from the process of formulating the solution and from examining the results.

In addition, at the time the revision of the sixth edition was underway, topics related to energy conversion were being re-introduced into a number of engineering curricula. Feedback from faculty involved in these programs led to the inclusion of a chapter which covered the basic principles of power electronics with an emphasis on their application to electric machines. The power-electronics chapter was of course not intended to be a substitute for a full-fledged course in power electronics. At this time, such courses exist in many engineering programs. Faculty members surveyed in advance of this seventh edition indicated that there is no longer a need for the power-electronics chapter. As a result, it has been removed from the seventh edition and moved to the seventh-edition website.

In considering this revision, there was no question of any change in the focus on fundamental physical principles underlying the performance of electric machines which has been the strength of ELECTRIC MACHINERY since the first edition. In addition, a survey of current adopters of the sixth edition indicated that, with the exception of elimination of the chapter on power electronics, there was no need to revise the range of topics covered. On the other hand, elimination of the power-electronics chapter resulted in space for expansion. Thus, the key features of this revision are:

- The presentation of all material in the book has been carefully reviewed, revised and/or expanded as needed for additional clarity. One such example is the expanded treatment of permanent-magnet ac machines in Chapter 5. Similarly, the dc-machine presentation of Chapter 7 has been reorganized for added clarity.

- 15 new examples have been added to this edition, bringing the total number of examples in the book to 111, and in addition, some of the examples from the previous edition have been revised.
- Of the total of 371 end-of-chapter problems in this edition, 96 are new problems. Almost all of the remaining problems, although retained in form from the previous edition, have been altered either in substance or numerically such that previous solutions are no longer valid.
- The use of MATLAB has been considerably expanded in the seventh edition, in examples, in practice problems and in end-of-chapter problems.
- New to this edition is a list of variables and their definitions included at the end of each chapter.
- The seventh edition introduces some simple examples of electric-machinery dynamics and includes a few MATLAB/Simulink[®] examples and problems.
- The majority of photographs from the previous edition have been updated.

As has been the case with past editions, it is highly likely that there is simply too much material in this edition of *ELECTRIC MACHINERY* for a single introductory course. The material has been organized so that instructors can pick and choose material appropriate to the topics which they wish to cover. The first two chapters introduce basic concepts of magnetic circuits, magnetic materials and transformers. The third chapter introduces the basic concept of electromechanical energy conversion. The fourth chapter then provides an overview of, and introduction to, the various machine types. Some instructors may choose to omit all or most of the material in Chapter 3 from an introductory course. This can be done without significantly impacting the presentation of the material in the remainder of the book.

The next five chapters provide a more in-depth discussion of the various machine types: synchronous machines in Chapter 5, induction machines in Chapter 6, dc machines in Chapter 7, variable-reluctance machines in Chapter 8 and single/two-phase machines in Chapter 9. Since the chapters are relatively independent (with the exception of the material in Chapter 9 which builds upon the polyphase-induction-motor discussion of Chapter 6), the order of these chapters can be changed and/or an instructor can choose to focus on only one or two machine types and not to cover the material in all five of these chapters.

Finally, instructors may wish to select topics from the control material of Chapter 10 rather than include it all. The material on speed control is a relatively straightforward extension of the material found in earlier chapters on the individual machine types. The material on field-oriented control requires a somewhat more sophisticated understanding and builds upon the dq0 transformation found in Appendix C. It would certainly be reasonable to omit this material in an introductory course and to delay it for a more advanced course where sufficient time is available to devote to it.

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Visit the textbook website at www.mhhe.com/umans7e. The sixth edition Power Electronics chapter has been posted to the website. For instructors, a downloadable

version of the solutions manual, PowerPoint slides of figures from the book, and PowerPoint lecture outlines are posted to the Instructor Edition. Copies of the MATLAB and Simulink files for the various examples used in the book are available for students and instructors.

My mother, Nettie Umans, passed away during the time of this revision. I had looked forward to sharing the seventh edition with her; she would have been excited to see it. She is deeply missed.

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